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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/813,240	03/20/2001	Wilfried Von Ammon	VON AMMON ET AL 9	1729

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EXAMINER

MONDT, JOHANNES P

ART UNIT PAPER NUMBER

2826

DATE MAILED: 04/15/2003

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/813,240

Applicant(s)

AMMON ET AL.

Examiner

Johannes P Mondt

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Period for Reply *The MAILING DATE of this communication appears on the cover sheet with the correspondence address --*

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 08 April 2003.
- 2a) ☐ This action is FINAL. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 2 and 4-6 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 2 and 4-6 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
- If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
- a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____
- 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other:

DETAILED ACTION

Response to Arguments

This office action is based on Applicant's After-Final Response (Request for Reconsideration) filed 4/8/2003 and entered as Paper No. 12 and on the outcome of the interview with Applicant's representative as documented in Paper No. 10 filed 3/18/2003. In said Response Applicant successfully traversed the rejections of claims 2 and 4-6, because the conditions under which Tamatsuka et al cite the use of their specific atmosphere pertain to the stage at which the ingot has already been pulled out of the melt and has been used to produce wafers. Tamatsuka et al can still be cited for the application of the Czochralski method of a silicon single crystal, doping the silicon single crystal with nitrogen at a concentration in a range that overlaps with the range as claimed by Applicant (cf. abstract and column 2, lines 33-44), and separating the silicon single crystal into wafers (column 2, lines 45-50). Furthermore, after a search update, it appears that the use of a partial hydrogen pressure during removal from the melt as prescribed by claim 2 is known in the art to be a consequence of a processing step that is advantageous for the production of highly pure silicon from a melt, because, as shown for instance by Hongu et al (6,036,932), the hydrogen chloride content of an otherwise inert atmosphere helps to cleanse the silicon from boron and phosphorous, while the dissociation energy of hydrogen chloride and hydrogen (molecular) gas are both about 4.4 to 4.5 eV (approximately 50,000 Kelvin), such that, under the temperature at which the melt is operated (between 1,500 and 1,650 Kelvin) a tiny but

measurable fraction of the hydrogen atoms in HCl dissociates into H atoms, while a large percentage of the resulting H atoms associate into H₂ gas at said temperature. The mixing ratio of inert gas (such as argon) and the reactive gas (such as hydrogen chloride) in Hongo et al is claimed (Hongo et al, claim 6) to be in the range between 19 to 99, and the reduced (overall) pressure as claimed (Hongo et al, claim 7) is in the range from 10⁻⁴ to 10⁻² Torr. The resulting partial hydrogen pressure is found to be less than that of HCl, which is in its turn less than between 0.001 and 0.5 mTorr. The hydrogen partial pressure range of the Prior Art is thus seen to overlap with the claimed range. Applicant is reminded that a prima facie case of obviousness typically exists when the ranges of a claimed composition overlaps the ranges disclosed in the prior art or when the ranges of a claimed composition does not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Motivation to include the teaching by Hongo et al in this regard in the invention as essentially taught by Tamatsuka et al stems from the role of the reactive component including hydrogen chloride (HCl), and hence including hydrogen gas, given the dissociation energies of H₂ and HCl, to improve the purity content of the resulting ingot (cf. abstract and Background of the Invention in Hongo et al). *Combination* (of said convention with said teaching) hinges only upon the creation of the atmosphere of argon and hydrogen chloride and thus does not depend on any other particulars in the arrangement by Tamatsuka et al. *Success* in the implementation of said combination can therefore be reasonably expected.

The rejections included below are based upon the above considerations.

Claim Rejections - 35 USC § 103

1. ***Claims 2 and 5*** are rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka et al (6,291,874 B1) in view of Hongu et al (6,036,932).

With regard to claim 2: Tamatsuka et al teach a method for producing a silicon semiconductor wafer comprising:

pulling a silicon single crystal from a melt, using the Czochralski method (cf. abstract);

doping the silicon single crystal with nitrogen and producing a nitrogen concentration in the range of 10^{10} to 5×10^{15} atoms/cm³, which range substantially overlaps with that of claim 2 of Applicant; Applicant is reminded that a prima facie case of obviousness typically exists when the ranges of a claimed composition overlaps the ranges disclosed in the prior art or when the ranges of a claimed composition does not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Tamatsuka et al also teach separating the silicon semiconductor wafer from the silicon single crystal (cf. column 2, lines 45-50).

Tamatsuka et al do not necessarily teach the atmosphere in which the single crystal is pulled to have a partial hydrogen atmosphere of less than 3 mbar. However, the use of a partial hydrogen pressure during removal from the melt as prescribed by claim 2 is known in the art to be a consequence of a processing step that is known in

the art to be advantageous for the production of highly pure silicon from a melt, because, as shown for instance by Hongu et al (6,036,932), the hydrogen chloride content of an otherwise inert atmosphere helps to cleanse the silicon from boron and phosphorous, while the dissociation energy of hydrogen chloride and hydrogen (molecular) gas are both about 4.4 to 4.5 eV (approximately 50,000 Kelvin), such that, under the temperature at which the melt is operated (between 1,500 and 1,650 Kelvin) a tiny but measurable fraction of the hydrogen atoms in HCl dissociates into H atoms, while a large percentage of the resulting H atoms associate into H₂ gas at said temperature. The mixing ratio of inert gas (such as argon) and the reactive gas (such as hydrogen chloride) in Hongu et al is claimed (Hongu et al, claim 6) to be in the range between 19 to 99, and the reduced (overall) pressure as claimed (Hongu et al, claim 7) is in the range from 10⁻⁴ to 10⁻² Torr. The resulting partial hydrogen pressure is found to be less than that of HCl, which is in its turn less than between 0.001 and 0.5 mTorr. The hydrogen partial pressure range of the Prior Art is thus seen to overlap with the claimed range. Applicant is reminded that a prima facie case of obviousness typically exists when the ranges of a claimed composition overlaps the ranges disclosed in the prior art or when the ranges of a claimed composition does not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003).

Motivation to include the teaching by Hongu et al in this regard in the invention as essentially taught by Tamatsuka et al stems from the role of the reactive component including hydrogen chloride (HCl), and hence including hydrogen gas, given the

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dissociation energies of H₂ and HCl, to improve the purity content of the resulting ingot (cf. abstract and Background of the Invention in Hongu et al). *Combination* (of said convention with said teaching) hinges only upon the creation of the atmosphere of argon and hydrogen chloride and thus does not depend on any other particulars in the arrangement by Tamatsuka et al. *Success* in the implementation of said combination can therefore be reasonably expected.

With regard to claim 5: Tamatsuka et al teach their method of wafer production to comprise subjecting the semiconductor wafer to a heat treatment in an atmosphere containing 75% argon and 25% hydrogen (cf. column 6, lines 47-56), instead of less than 3% as claimed by Applicant. The further limitation of claim 5 is thus not necessarily fulfilled in Tamatsuka et al, nor in Hongu et al. However, Applicant does not explain why the range for the hydrogen content of the argon-hydrogen atmosphere as defined by claim 5 is *critical* to his invention. Applicant is reminded that it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the optimum or working ranges involves only routine skill in the art. In re Aller, 105 USPQ 233.

2. **Claim 4** is rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka et al and Hongu et al as applied to claim 2 above, and further in view of Kim (5,942,032) and Tamatsuka et al (6,299,982) (previously denoted as "Tamatsuka2").

As detailed above, claim 1 is unpatentable over Tamatsuka et al in view of Hongu et al, neither of whom, however, necessarily teach the further limitation as defined by claim 4.

However, the use of a heat shield in the context of the Czochralski method for selectively shielding a semiconductor single crystal ingot is widely known in the art; see Kim et al (cf. abstract and claim 1 starting at column 10), which is closely related art, namely: the control of the composition of and suppress the agglomeration of crystal defects (see "Background of the Invention", first paragraph) within the context of a silicon single crystal grown using the Czochralski method (cf. abstract, first sentence).

The purpose of the use of the aforementioned heat shield, namely the selective shielding of the monocrystalline ingot to control the type and number density of agglomerated defects in the crystal structure is fully relevant to the invention taught by Tamatsuka et al that aims at a reduction of the number of pits on the wafer surface (cf. column 1, lines 9-11), and therefore there exists ample *motivation* to combine the inventions. It is indeed possible to *combine* the inventions because the addition of a heat shield does not interfere with any of the requirements in the invention taught by Tamatsuka et al. *Expectation of success is reasonable* in view of the success of the use of heat shields in the context of the Czochralski method as shown by Kim et al.

Furthermore, although neither of the references cited in connexion with claim 2 necessarily teach the further limitation of cooling the silicon crystal from a temperature of 1050 to 900 degrees Celsius in less than 120 minutes, Tamatsuka et al in US Patent 6,299,982 B1, henceforth denoted by "Tamatsuka2" teach cooling defined by a range that is close to the one given in Applicant's claim, i.e., from 1150 to 1080, at a rate of 2.3 minutes or more, which falls in the range of Applicant's rate of 1.25 degrees per minute or more. Although the temperature range given by Tamatsuka2 is (slightly: less

than 3 percent difference) different from Applicant's, Applicant fails to show why his range is critical to the invention. A prima facie case of obviousness typically exists when the ranges of a claimed composition overlaps the ranges disclosed in the prior art or when the ranges of a claimed composition does not overlap but are close enough such that one skilled in the art would have expected them to have the same properties. In re Peterson, 65 USPQ2d 1379 (CA FC 2003). A difference in temperature by a mere 3 percent would not, by anyone skilled in the art, be a priori expected to yield different properties.

3. **Claim 6** is rejected under 35 U.S.C. 103(a) as being unpatentable over Tamatsuka and Hongu et al as applied to claim 2 above, and further in view of Tamatsuka et al (6,224,668) (all references except Hongu et al have been made of record previously). As detailed above, claim 2 is unpatentable over Tamatsuka et al in view of Hongu et al, who, however, do not necessarily teach subjecting the semiconductor wafer to an oxidation treatment. However, the inclusion of oxygen as a reactant in the atmosphere during heat treatment within the context of the Czochralski method of producing a silicon single crystal wafer with reduced defects is well known in the art as exemplified by Tamatsuka et al (6,224,668) who teach the oxidation of a silicon substrate obtained as a wafer from a silicon ingot produced using the Czochralski method (cf. abstract) for the specific purpose of producing a silicon-on-oxide (SOI) substrate of use in SOI semiconductor technology, thereby not only producing the silicon layer but also the oxide layer and thus improving the efficiency of

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the SOI production process. Motivation is efficiency of production; combinability follows from the identically used crystal growth method to which the oxidation process is a mere addendum. Success can be reasonably expected in view of the circumstance that both ingredients in the overall process, i.e., the Czochralski method of crystal formation and the oxidation of a silicon layer, are well-tested technologies.

Conclusion

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Johannes P Mondt whose telephone number is 703-306-0531. The examiner can normally be reached on 8:00 - 18:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nathan J Flynn can be reached on 703-308-6601. The fax phone numbers for the organization where this application or proceeding is assigned are 703-308-7722 for regular communications and 703-308-7724 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0956.

NATHAN J. FLYNN
SUPERVISORY PATENT EXAMINER
TECHNOLOGY CENTER 2800

JPM
April 13, 2003